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ABSTRACT

A description and application of the Frostig Developmental Test of Visual Perception are presented. The report includes a description of the Frostig as a total instrument and an overall analysis, as well as separate analyses and descriptions of each subtest. A brief summary of the experimental design and sampling plan also is included. A pilot study included administration of the Frostig to a sample of children, ages 3 to 6 years, in northern West Virginia. The results of this testing indicated overall deficits in the areas of figure-ground perception and form-constancy tasks. Results of the study indicate that paraprofessional personnel made a significant contribution in the area of same-different discrimination in terms of spacial rotation and that the television program had its major effect on eye-motor coordination, shape constancy, and the ability to conserve patterns after spatial rotation. (Author/CK)

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Analysis of Visual Perception Of Children in the Appalachia Preschool Education Program

Technical Report 16

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Analysis of Visual Perception of Children in the Appalachia Preschool Education Program

Introduction

A large proportion of the initial Preschool Education Program curriculum (Hooper and Marshall, 1968) and the subsequent program materials are devoted to teaching motor coordination and perceptual learning tasks. Because of the difficulty of developing specific measures for these objectives and because of its previous use in evaluating preschool programs, the Marianne Frostig Developmental Test of Visual Perception was used to measure behavioral change in these areas.

As a program evaluation instrument, the Frostig shares several problems with the ITPA. Neither was designed to be a specific measure of program effects; both are administered individually, and thus are susceptible to examiner bias. In addition, both instruments were designed to be diagnostic of perceptual, expressive, and motor deficits rather than to measure overall treatment effects. However, the Frostig test does provide a potentially valid and reliable measure of perceptual development in the preschool-age child, and most important, it provides national norms for comparison with a sample outside of the AEL region.

This report includes a description of the Frostig as a total instrument and an overall analysis, as well as separate analyses and descriptions of each subtest. A brief summary of the experimental design and sampling plan also is included.

Method

A pilot study by Hooper and Marshall (1968) included administration of the Frostig to a sample of children, ages 3 to 6 years, in northern West Virginia. The results of this testing indicated overall deficits in the

areas of figure-ground perception and form-constancy tasks, as measured by Subtests 2 and 3. Both of those skills were cited by the test authors as being relevant to reading readiness. In order to investigate the Hooper-Marshall data, and as a method of measuring program effects on motor learning and perceptual development, the Frostig was included as a major evaluation instrument for the Appalachia Preschool Education Program.

Data were collected in June and September of 1970 from a sample of children in three treatment groups and a control group. The three treatment groups were:

- A group which received an instructional television program in their homes (TV only).
- A group which received the TV program plus weekly visits by a paraprofessional home visitor (TV-HV).
- A group which received the TV program, a home visit, and which also visited a mobile classroom (TV-HV-MC).

These pretest data were compared to results of a post-test administered in June of 1971. Details of the sampling procedure and a description of each group are included in the introduction to this report.

The primary data analysis technique consisted of analysis of covariance using post-test data, with age in months as of June, 1971, and the PPVT post-test raw score as covariates. A preliminary three-way analysis of variance on post-test scores revealed treatment differences in the covariates. Similar analyses were performed on gain scores, and these results will be included where appropriate.

The nature of the statistical methods used precludes definite cause and effect reasoning; however, the existence of significant differences between group means when these differences were not evident on the pretest was assumed to reflect genuine treatment effects.

It is assumed that the use of chronological age as a covariate adjusts for differences in mean age among treatment groups. It should be noted, however, that the group with the highest mean age (TV only) produced the lowest mean scores on most subtests of the evaluation battery. Thus, the use of covariance analysis was a conservative procedure and may have obscured actual program effects.

The eta^2 values presented in the ANCOVA tables are derived only for four sources: treatment, sex, the interaction of these variables, and the error term. They represent the proportion of variance accounted for by each source.

Description of Instrument and Results of Analysis

The Frostig is designed primarily as a method of assessing perceptual development in the visual area. However, hand-eye coordination and overall motor skills are involved in the child's responses to the visual configurations on the test. With the Frostig, unlike ITPA, it is difficult to separate the receptive processes (visual acuity) from the mediating activity (figure recognition) and the expressive act (drawing, outlining, etc.). For this reason the instrument is considered to be an indicator of perceptual-motor development in the program evaluation plan, and no effort is made to separate the two areas of functioning which may cause variance on the total test scores. Each of the following subtests has fairly high "face" validity, and it is assumed that each measures the general area to which it is attributed. Technical Report No. 17 further explores the factorial validity of this test.

Frostig Subtest 1 (Eye Motor Coordination)

The authors state that this subtest is "... a test of eye-hand coordination involving the drawing of continuous straight, curved, or angled lines between boundaries of various width, or from point to point without guidelines." (Frostig, 1966.)

Mean raw scores, standard deviations, and numbers of subjects according to age, sex, and treatment group for Subtest 1 are presented in Table 16.1 along with overall treatment group means for pre and post-test measures. The adjusted means from the ANCOVA are graphically represented in Figure 16.1 along with the mean scores of the Frostig normative sample. Note that the adjusted means in Figure 16.1 differ slightly from the raw score total means in Table 16.1.

As shown in Figure 16.1, two treatment groups and the control group scored slightly below the norm, while one group (TV-HV-MC) slightly exceeded the norm. The analysis of covariance summary table is presented in Table 16.2. The treatment effect was significant at the .01 level of confidence.

(4)

Table 16.1

Frostig Subtest 1 (Eye Motor Coordination) Pre and Post-test Mean Raw Scores, Standard Deviations, and Numbers of Subjects by Age and Sex within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 4.83 N= 10 σ= 5.61	$\bar{x}$= 5.50 N= 12 σ= 1.85	$\bar{x}$= 6.58 N= 11 σ= 5.88	$\bar{x}$= 5.13 N= 16 σ= 2.78	$\bar{x}$= 5.13 N= 11 σ= 6.68	$\bar{x}$= 5.50 N= 8 σ= 2.96	$\bar{x}$= 2.63 N= 8 σ= 2.60	$\bar{x}$= 5.24 N= 17 σ= 1.66
	F	$\bar{x}$= 6.67 N= 11 σ= 5.20	$\bar{x}$= 8.38 N= 13 σ= 3.58	$\bar{x}$= 3.30 N= 10 σ= 3.98	$\bar{x}$= 4.61 N= 18 σ= 2.26	$\bar{x}$= 3.60 N= 5 σ= 2.24	$\bar{x}$= 5.00 N= 5 σ= 4.20	$\bar{x}$= 2.50 N= 8 σ= 2.12	$\bar{x}$= 4.58 N= 19 σ= 3.31
4	M	$\bar{x}$= 9.67 N= 9 σ= 6.34	$\bar{x}$= 8.85 N= 20 σ= 3.15	$\bar{x}$= 10.20 N= 9 σ= 3.87	$\bar{x}$= 7.96 N= 25 σ= 3.09	$\bar{x}$= 8.15 N= 13 σ= 6.04	$\bar{x}$= 10.79 N= 14 σ= 3.14	$\bar{x}$= 4.30 N= 13 σ= 2.14	$\bar{x}$= 6.74 N= 17 σ= 3.42
	F	$\bar{x}$= 8.78 N= 9 σ= 7.92	$\bar{x}$= 9.05 N= 19 σ= 3.14	$\bar{x}$= 15.00 N= 10 σ= 4.35	$\bar{x}$= 9.39 N= 22 σ= 3.44	$\bar{x}$= 9.60 N= 10 σ= 7.06	$\bar{x}$= 10.39 N= 8 σ= 5.17	$\bar{x}$= 5.54 N= 13 σ= 2.40	$\bar{x}$= 6.95 N= 17 σ= 2.77
5	M	$\bar{x}$= 14.50 N= 13 σ= 8.11	$\bar{x}$= 12.31 N= 16 σ= 3.69	$\bar{x}$= 19.60 N= 8 σ= 4.37	$\bar{x}$= 11.22 N= 27 σ= 2.90	$\bar{x}$= 13.60 N= 8 σ= 8.15	$\bar{x}$= 9.83 N= 12 σ= 2.76	$\bar{x}$= 7.78 N= 9 σ= 4.09	$\bar{x}$= 9.67 N= 18 σ= 3.42
	F	$\bar{x}$= 10.40 N= 11 σ= 5.32	$\bar{x}$= 11.40 N= 15 σ= 2.85	$\bar{x}$= 10.40 N= 10 σ= 2.95	$\bar{x}$= 10.77 N= 22 σ= 3.04	$\bar{x}$= 13.54 N= 13 σ= 7.48	$\bar{x}$= 11.11 N= 19 σ= 3.32	$\bar{x}$= 10.10 N= 10 σ= 3.78	$\bar{x}$= 9.88 N= 15 σ= 2.63
TOTAL		$\bar{x}$= 9.37 N= 63 σ= 6.55	$\bar{x}$= 9.39 N= 95 σ= 3.13	$\bar{x}$= 10.48 N= 58 σ= 4.36	$\bar{x}$= 8.52 N= 130 σ= 4.36	$\bar{x}$= 9.35 N= 60 σ= 6.77	$\bar{x}$= 9.58 N= 66 σ= 3.51	$\bar{x}$= 5.57 N= 61 σ= 2.91	$\bar{x}$= 7.16 N= 105 σ= 2.95

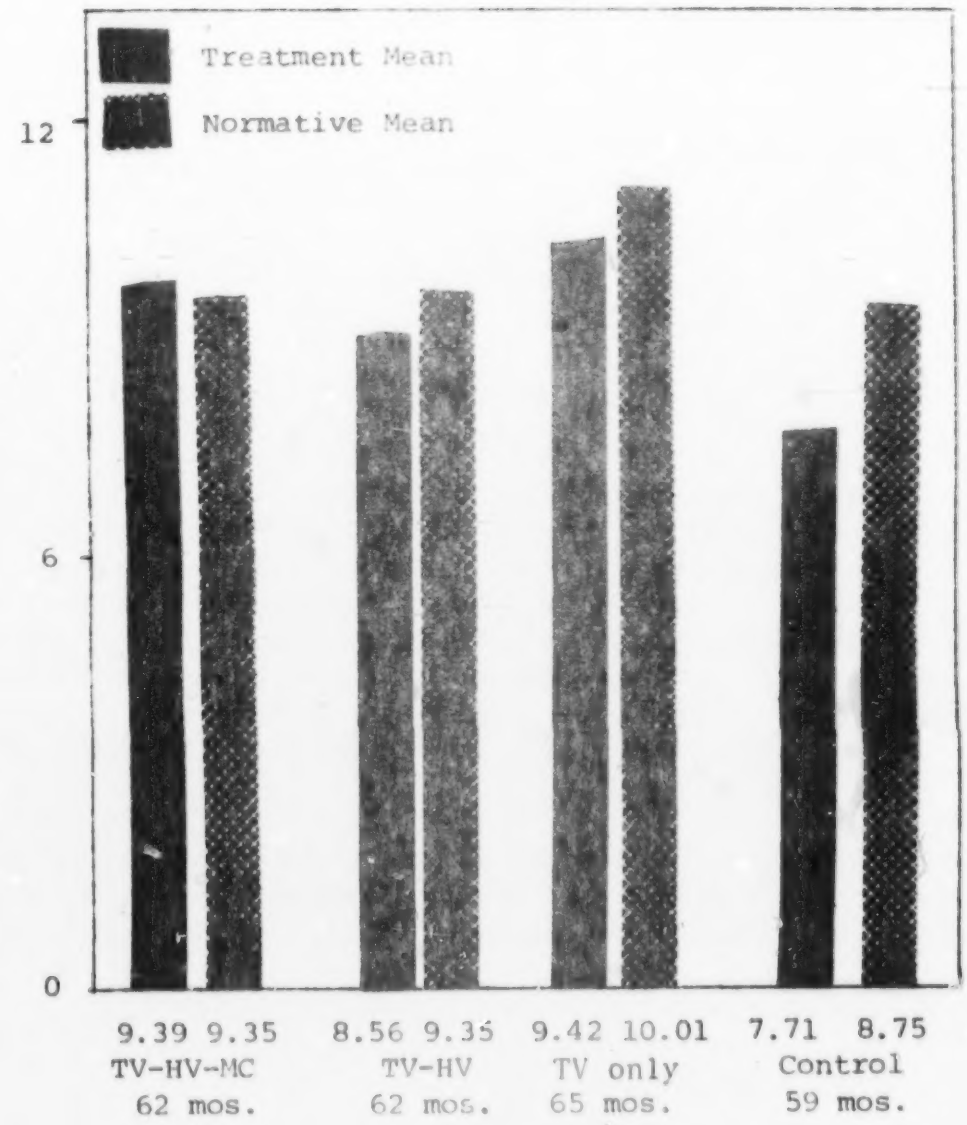

Figure 16.1

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups--
Frostig Subtest 1

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Table 16.2

Analysis of Covariance Table for Frostig Subtest 1

Source	η^2	d.f.	Mean Square	F	p
Trt.	.023	3	62.34	5.94	p < .01
Sex	.03	1	23.15	2.20	--
Trt. by Sex	.01	3	3.10	0.30	--
Covs.		2	14976.81	1426.18	--
Cov. 1		1	386.27	36.78	--
Cov. 2		1	227.91	21.70	--
Error	.73	392	10.50		

A Dunnett's post-hoc comparison indicated that the contrasts between the three treatment groups and the control group contributed to the significant F-ratio. Differences between treatment group means were not significant, indicating that the television component probably was responsible for the higher level of performance of children in treatment groups. A similar pattern was evident in the previous year's data. The relatively small differences between the treatment group means and the normative means do not seem to be indicative of an overall trend to lower scores for the Appalachian sample.

The television program stresses objectives which involve the child with the use of paint brushes, crayons, and other art materials which may well add to the overall level of perceptual-motor functioning measured by this subtest.

Frostig Subtest 2 (Figure-Ground)

Frostig Subtest 2, according to the authors, is a measure of ability to perceive "... shifts in perception of figures against increasingly complex grounds. Intersecting and 'hidden' geometric forms are used." (Frostig, 1966.) Subtest 2 is thought to correlate highly with reading readiness, in that it measures the ability to discriminate shapes and configurations from their context. The same ability is necessary in recognition of letters and numbers in written material.

Table 16.3 shows mean raw scores, standard deviations, and numbers of subjects for each age-by-sex cell within the four treatments. It also shows the same parameters collapsed across treatment groups.

The adjusted overall means from the ANCOVA are presented graphically in Figure 16.2 along with the national norms for the comparable ages in each treatment condition.

Table 16.3

Frostig Subtest 2 (Figure-Ground) Pre and Post-test Mean Raw Scores, Standard Deviations, and Numbers of Subjects by Age and Sex within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 0.50 N= 10 σ= 0.67	$\bar{x}$= 3.50 N= 12 σ= 2.96	$\bar{x}$= 1.50 N= 11 σ= 2.06	$\bar{x}$= 5.81 N= 16 σ= 3.81	$\bar{x}$= 0.90 N= 11 σ= 1.00	$\bar{x}$= 2.00 N= 8 σ= 2.40	$\bar{x}$= 1.50 N= 8 σ= 2.55	$\bar{x}$= 3.82 N= 17 σ= 3.01
	F	$\bar{x}$= 1.81 N= 11 σ= 1.75	$\bar{x}$= 5.92 N= 13 σ= 3.97	$\bar{x}$= 1.20 N= 10 σ= 1.46	$\bar{x}$= 5.28 N= 18 σ= 4.59	$\bar{x}$= 2.60 N= 5 σ= 3.56	$\bar{x}$= 2.60 N= 5 σ= 3.77	$\bar{x}$= 2.12 N= 8 σ= 2.52	$\bar{x}$= 4.53 N= 19 σ= 3.95
4	M	$\bar{x}$= 3.25 N= 9 σ= 3.69	$\bar{x}$= 9.75 N= 20 σ= 4.77	$\bar{x}$= 2.89 N= 9 σ= 5.84	$\bar{x}$= 9.56 N= 25 σ= 4.82	$\bar{x}$= 5.00 N= 13 σ= 5.44	$\bar{x}$= 11.71 N= 14 σ= 4.65	$\bar{x}$= 4.15 N= 13 σ= 5.01	$\bar{x}$= 7.32 N= 17 σ= 5.55
	F	$\bar{x}$= 2.75 N= 9 σ= 4.17	$\bar{x}$= 10.74 N= 19 σ= 6.38	$\bar{x}$= 5.10 N= 10 σ= 5.70	$\bar{x}$= 11.78 N= 22 σ= 4.80	$\bar{x}$= 1.10 N= 10 σ= 1.60	$\bar{x}$= 8.75 N= 8 σ= 6.72	$\bar{x}$= 4.62 N= 13 σ= 5.72	$\bar{x}$= 9.55 N= 17 σ= 5.01
5	M	$\bar{x}$= 7.92 N= 13 σ= 6.30	$\bar{x}$= 15.00 N= 16 σ= 5.01	$\bar{x}$= 12.40 N= 8 σ= 4.70	$\bar{x}$= 15.04 N= 27 σ= 4.48	$\bar{x}$= 4.50 N= 8 σ= 5.37	$\bar{x}$= 11.42 N= 12 σ= 5.57	$\bar{x}$= 8.67 N= 9 σ= 6.14	$\bar{x}$= 12.50 N= 18 σ= 5.70
	F	$\bar{x}$= 8.72 N= 11 σ= 6.42	$\bar{x}$= 13.27 N= 15 σ= 4.86	$\bar{x}$= 9.10 N= 10 σ= 6.19	$\bar{x}$= 15.64 N= 22 σ= 3.87	$\bar{x}$= 6.84 N= 13 σ= 6.00	$\bar{x}$= 13.68 N= 19 σ= 5.05	$\bar{x}$= 11.00 N= 10 σ= 6.18	$\bar{x}$= 13.75 N= 15 σ= 4.89
TOTAL		$\bar{x}$= 4.41 N= 63 σ= 4.51	$\bar{x}$= 10.09 N= 95 σ= 4.91	$\bar{x}$= 5.10 N= 58 σ= 4.66	$\bar{x}$= 11.02 N=130 σ= 4.45	$\bar{x}$= 3.73 N= 60 σ= 4.44	$\bar{x}$= 10.00 N= 66 σ= 4.98	$\bar{x}$= 5.43 N= 61 σ= 5.08	$\bar{x}$= 8.62 N=105 σ= 4.77

(7)

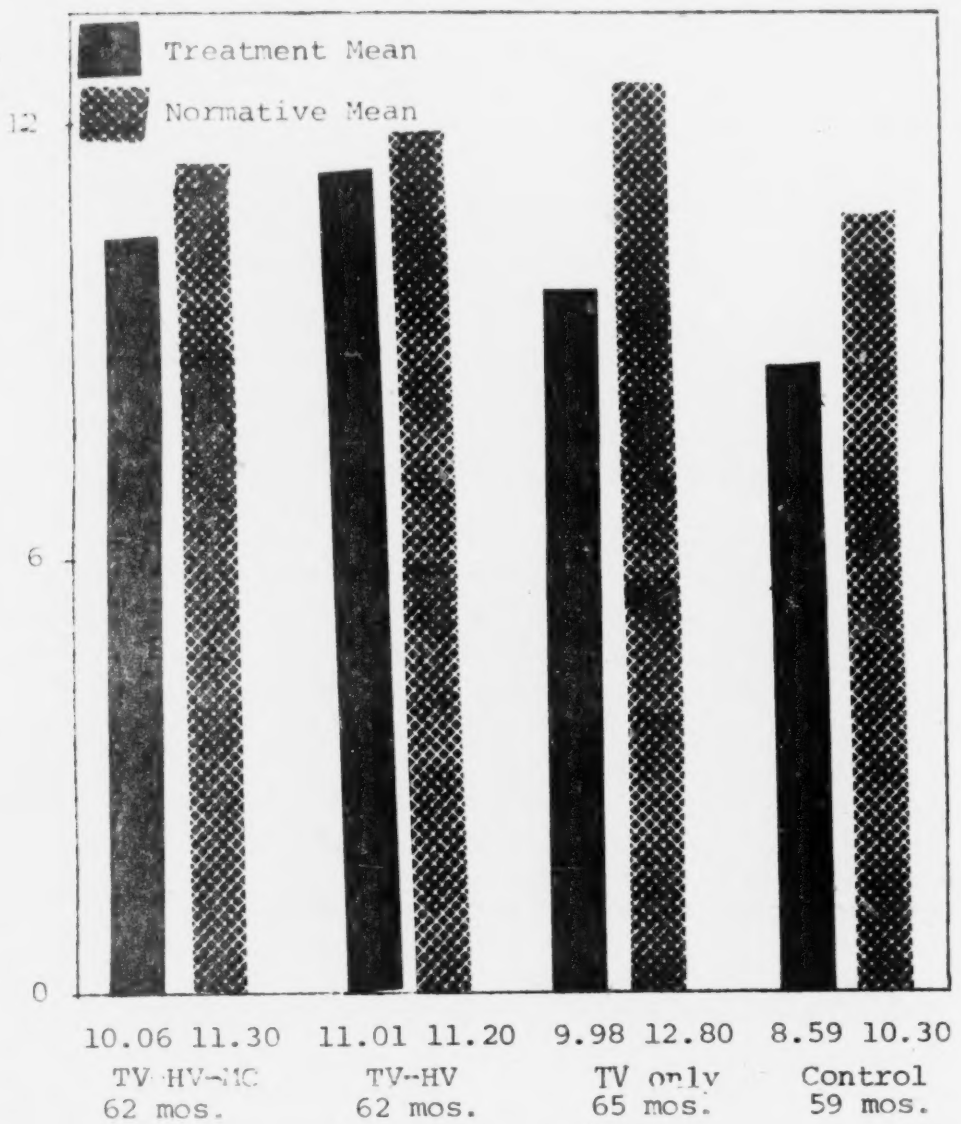

Figure 16.2

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups-- Frostig Subtest 2

A three-way ANOVA on post-test scores showed a statistically significant ($p < .005$) treatment effect for Frostig Subtest 2. Since the ANCOVA did not show this effect, it is assumed that the significant ANOVA treatment effect was attributable to a factor which was controlled in the ANCOVA. Similar results were observed in the previous year's data.

The summary of the analysis of covariance is presented in Table 16.4.

(8)

Table 16.4

Analysis of Covariance Table for Frostig Subtest 2

Source	η^2	d.f.	Mean Square	F	p
Trt.	.02	3	52.50	2.03	--
Sex	.02	1	162.40	6.28	$p < .05$
Trt. by Sex	.001	3	3.79	0.15	--
Covs.		2	20825.35	805.71	--
Cov. 1		1	13.89	0.54	--
Cov. 2		1	1377.61	53.30	--
Error	.97	392	25.85		

Table 16.5 shows adjusted means by sex for each treatment collapsed across age. As can be seen from these data, females outscored males in all four treatment groups. This result is unusual in the light of the findings of an earlier study (Hooper and Marshall, 1968, p. 77) which found significant male superiority on this measure in the 5½-year-old group.

Table 16.5

Adjusted Post-test Means for Males and Females on Frostig Subtest 2

	TV-HV-MC	TV-HV	TV	C
M	9.94	10.85	9.32	8.23
F	10.21	11.19	10.72	9.00

An ANCOVA on gain scores, using age and PPVT raw score as covariates, did not show significant sex effects, although it did identify a significant treatment effect. It seems likely that the differential treatment effects served to equalize post-test scores across groups.

Frostig Subtest 3 (Constancy of Shape)

This section is designed to measure "... recognition of certain geometric figures presented in a variety of sizes, shadings, textures, and positions in spaces, and their discrimination from similar geometric figures. Circles, squares, rectangles, ellipses, and parallelograms are used." (Frostig, 1966, p. 5.)

(10)

Table 16.6

Frostig Subtest 3 (Constancy of Shape) Pre and Post-test Mean Raw Scores, Standard Deviations, and Numbers of Subjects by Age and Sex within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 0.20 N= 10 σ= 0.40	$\bar{x}$= 2.50 N= 12 σ= 2.60	$\bar{x}$= 1.25 N= 11 σ= 1.92	$\bar{x}$= 4.00 N= [illegible] σ= 1.73	$\bar{x}$= 0.90 N= 11 σ= 1.24	$\bar{x}$= 0.38 N= 8 σ= 0.48	$\bar{x}$= 1.75 N= 8 σ= 1.56	$\bar{x}$= 2.94 N= 17 σ= 1.86
	F	$\bar{x}$= 2.00 N= 11 σ= 1.90	$\bar{x}$= 4.85 N= 13 σ= 3.21	$\bar{x}$= 1.10 N= 10 σ= 1.87	$\bar{x}$= 3.06 N= 18 σ= 2.56	$\bar{x}$= 1.40 N= 5 σ= 1.20	$\bar{x}$= 2.20 N= [illegible] σ= 2.04	$\bar{x}$= 1.38 N= 8 σ= 1.49	$\bar{x}$= 1.89 N= 19 σ= 2.48
4	M	$\bar{x}$= 3.50 N= 9 σ= 3.20	$\bar{x}$= 6.05 N= 20 σ= 3.25	$\bar{x}$= 3.78 N= 9 σ= 4.00	$\bar{x}$= 4.60 N= 25 σ= 3.22	$\bar{x}$= 3.23 N= 13 σ= 3.40	$\bar{x}$= 6.43 N= 14 σ= 4.58	$\bar{x}$= 3.15 N= 13 σ= 2.47	$\bar{x}$= 3.00 N= 17 σ= 2.27
	F	$\bar{x}$= 4.50 N= 9 σ= 3.16	$\bar{x}$= 8.58 N= 19 σ= 3.69	$\bar{x}$= 4.00 N= 10 σ= 2.30	$\bar{x}$= 7.48 N= 22 σ= 3.73	$\bar{x}$= 1.40 N= 10 σ= 2.06	$\bar{x}$= 5.00 N= 8 σ= 4.18	$\bar{x}$= 2.92 N= 13 σ= 2.40	$\bar{x}$= 3.50 N= 17 σ= 2.14
5	M	$\bar{x}$= 3.54 N= 13 σ= 3.20	$\bar{x}$= 10.13 N= 16 σ= 3.62	$\bar{x}$= 5.38 N= 8 σ=	$\bar{x}$= 7.33 N= 27 σ= 3.21	$\bar{x}$= 3.25 N= 8 σ= 2.87	$\bar{x}$= 6.17 N= 12 σ= 3.95	$\bar{x}$= 2.00 N= 9 σ= 1.73	$\bar{x}$= 4.56 N= 18 σ= 3.50
	F	$\bar{x}$= 5.81 N= 11 σ= 4.00	$\bar{x}$= 7.80 N= 15 σ= 3.78	$\bar{x}$= 6.20 N= 10 σ= 4.54	$\bar{x}$= 8.45 N= 22 σ= 4.41	$\bar{x}$= 3.69 N= 13 σ= 4.44	$\bar{x}$= 6.84 N= 19 σ= 4.02	$\bar{x}$= 4.80 N= 10 σ= 4.39	$\bar{x}$= 5.56 N= 15 σ= 3.21
TOTAL		$\bar{x}$= 3.27 N= 63 σ= 2.90	$\bar{x}$= 6.91 N= 95 σ= 3.45	$\bar{x}$= 3.51 N= 58 σ= 2.87	$\bar{x}$= 6.02 N=130 σ= 3.32	$\bar{x}$= 2.45 N= 60 σ= 3.07	$\bar{x}$= 5.27 N= 66 σ= 3.79	$\bar{x}$= 2.79 N= 61 σ= 2.60	$\bar{x}$= 3.76 N=105 σ= 2.64

Since these figures are relatively common, it would be expected that the child's familiarity with the shapes would correlate positively with his performance on the test. Many of the program's curriculum objectives do involve recognition and labeling of these and similar geometric figures and thus could be expected to influence scores on this subtest.

Table 16.6 presents means, standard deviations, and numbers of subjects for each age-by-sex-cell within the four treatment groups, as well as for groups on both pre and post-test measures. Overall means, adjusted for age and PPVT raw score from the analysis of covariance, are presented in Figure 16.3, along with normative means for equivalent age groups.

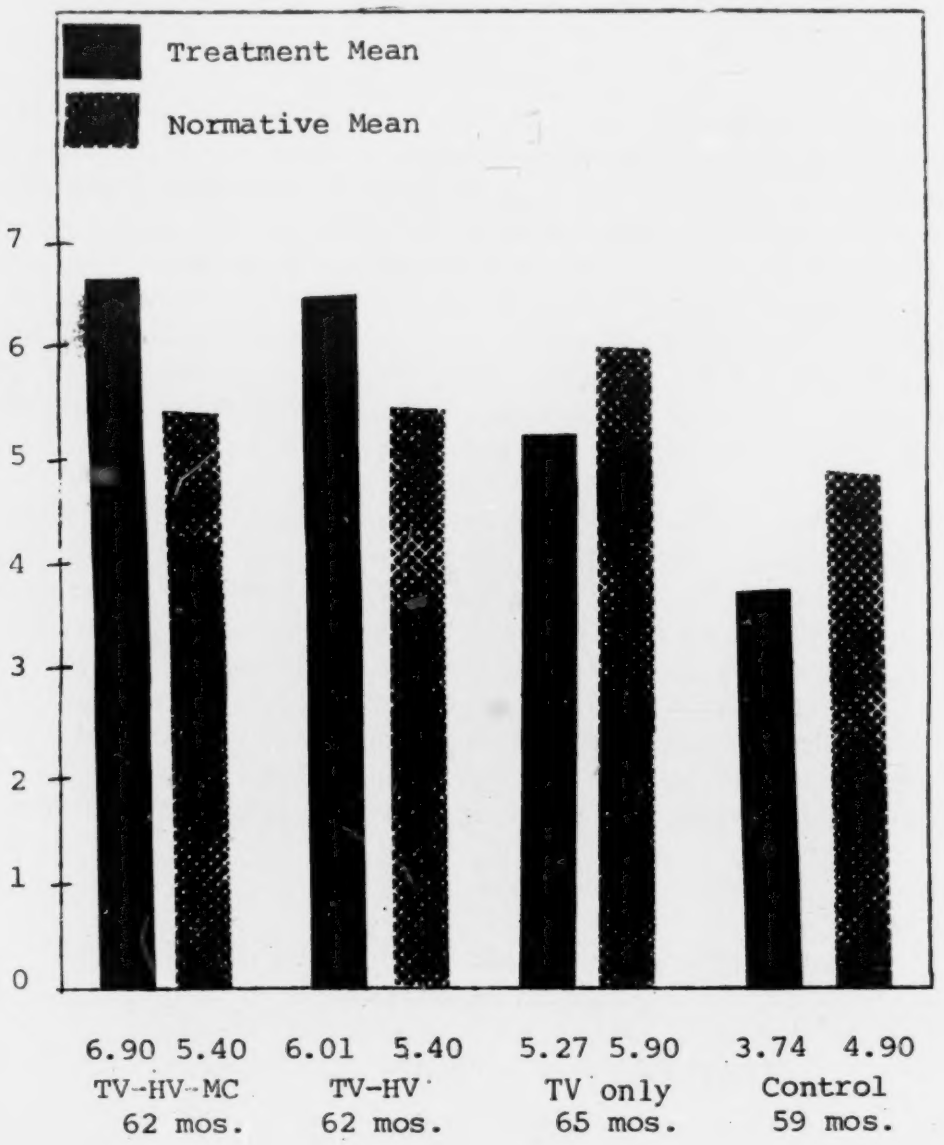

Figure 16.3

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups--
Frostig Subtest 3

Table 16.7

Analysis of Covariance Table for Frostig Subtest 3

Source	η^2	d.f.	Mean Square	F	p
Trt.	.07	3	110.84	9.84	$p < .005$
Sex	.02	1	100.87	8.95	$p < .005$
Trt. by Sex	.00	3	2.08	0.18	--
Covs.		2	6282.82	557.69	--
Cov. 1		1	0.76	0.07	--
Cov. 2		1	540.61	47.99	--
Error	.91	392	11.27		

Table 16.7 summarizes the results of the ANCOVA on post-test scores for this subtest. Treatment effects for Subtest 3 seem to stem from the linear increments apparent in Figure 16.3. A Dunnett's post-hoc comparison failed to reveal any single pair of means whose difference was great enough to be significant. Inspection of Figure 16.3 suggests that both the television program and home visitor contributed to children's performance on tasks measured by Subtest 3, a finding which was also evident in the previous year's data. Also, it is of interest that the two groups which were visited by a paraprofessional scored above the national normative means for comparable age groups while the other groups scored below the norms.

The significant sex effect on this subtest is illustrated in Table 16.8 which gives adjusted means for boys and girls of all ages over the four treatment conditions. As was the case for Subtest ?, females outscored males in all groups. The test's author cites Subtests 2 and 3 as being related to reading readiness in first grade children. It may well be that girls are more receptive to this type of learning experience. In the pilot assessment, Hooper found female superiority only in the 4½-year-old group, while males scored significantly higher in the 5½-year-old group. The latter group most closely resembles the mean age in the four treatments.

Table 16.8

Adjusted Post-test Means for Males and Females on Frostig Subtest 3

	TV-HV-MC	TV-HV	TV	C
M	6.52	5.54	4.91	3.62
F	7.30	6.55	5.66	3.91

(12)

Since it is not possible to show that the mobile facility and the home visitor added significantly to the learning the children received from the television program, it may well be that the identification and labeling which took place as the child was exposed to the visual stimuli were responsible for the differences found. It also is possible that the para-professional and the teacher did not stress recognition of geometric shapes as the television program did.

Frostig Subtest 4 (Position in Space)

This particular measure involves "... the discrimination of reversals and rotating of figures presented in series. Schematic drawing representing common objects are used." (Frostig, 1966, p. 5.)

The ability to follow explicit directions and the ability to comprehend the meaning of same and different probably are involved in making correct responses to this subtest. Table 16.9 presents the raw score means and numbers of subjects for each age by sex and treatment cell for Frostig Subtest 4.

For purposes of comparison, the adjusted post-test means are presented in Figure 16.4 along with national norms for each treatment group. Average ages in months are given below each group.

As is apparent from Figure 16.4, differences exist between treatment groups as well as between treatment and normative groups. The implications of these differences are clarified in Table 16.10, which presents a summary of the ANCOVA results for Subtest 4.

Table 16.9

Frostig Subtest 4 (Position in Space) Pre and Post-test Mean Raw Scores, Standard Deviations, and Numbers of Subjects by Age and Sex within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 1.75 N= 10 σ= 1.63	$\bar{x}$= 2.75 N= 12 σ= 1.30	$\bar{x}$= 2.67 N= 11 σ= 1.11	$\bar{x}$= 3.19 N= 16 σ= 1.18	$\bar{x}$= 1.82 N= 11 σ= 1.19	$\bar{x}$= 1.75 N= 8 σ= 0.97	$\bar{x}$= 2.00 N= 8 σ= 1.12	$\bar{x}$= 2.12 N= 17 σ= 1.23
	F	$\bar{x}$= 2.33 N= 11 σ= 1.11	$\bar{x}$= 3.00 N= 13 σ= 0.96	$\bar{x}$= 2.00 N= 10 σ= 1.18	$\bar{x}$= 2.28 N= 18 σ= 2.41	$\bar{x}$= 1.80 N= 5 σ= 0.40	$\bar{x}$= 1.40 N= 5 σ= 1.02	$\bar{x}$= 1.88 N= 8 σ= 1.17	$\bar{x}$= 1.89 N= 19 σ= 0.91
4	M	$\bar{x}$= 3.00 N= 9 σ= 0.70	$\bar{x}$= 4.55 N= 20 σ= 1.47	$\bar{x}$= 3.22 N= 9 σ= 0.83	$\bar{x}$= 4.24 N= 25 σ= 1.82	$\bar{x}$= 3.69 N= 13 σ= 1.43	$\bar{x}$= 4.07 N= 14 σ= 1.83	$\bar{x}$= 2.62 N= 13 σ= 1.12	$\bar{x}$= 2.42 N= 17 σ= 1.33
	F	$\bar{x}$= 2.44 N= 9 σ=	$\bar{x}$= 3.79 N= 19 σ= 1.36	$\bar{x}$= 3.20 N= 10 σ=	$\bar{x}$= 6.43 N= 22 σ= 12.82	$\bar{x}$= 3.50 N= 10 σ=	$\bar{x}$= 2.50 N= 8 σ= 1.12	$\bar{x}$= 2.00 N= 13 σ=	$\bar{x}$= 2.80 N= 17 σ= 0.99
5	M	$\bar{x}$= 4.62 N= 13 σ= 0.96	$\bar{x}$= 5.69 N= 16 σ= 1.57	$\bar{x}$= 5.13 N= 8 σ= 1.64	$\bar{x}$= 4.78 N= 27 σ= 1.81	$\bar{x}$= 3.25 N= 8 σ= 1.58	$\bar{x}$= 4.58 N= 12 σ= 1.93	$\bar{x}$= 3.33 N= 9 σ= 1.58	$\bar{x}$= 3.69 N= 18 σ= 1.37
	F	$\bar{x}$= 4.00 N= 11 σ= 1.95	$\bar{x}$= 5.20 N= 15 σ= 1.42	$\bar{x}$= 4.40 N= 10 σ= 1.83	$\bar{x}$= 5.05 N= 22 σ= 1.66	$\bar{x}$= 3.92 N= 13 σ= 1.66	$\bar{x}$= 3.84 N= 19 σ= 2.01	$\bar{x}$= 2.60 N= 10 σ= 1.17	$\bar{x}$= 3.31 N= 15 σ= 0.60
TOTAL		$\bar{x}$= 3.11 N= 63 σ= 1.25	$\bar{x}$= 4.25 N= 95 σ= 1.38	$\bar{x}$= 3.37 N= 58 σ= 1.24	$\bar{x}$= 4.48 N=130 σ= 5.53	$\bar{x}$= 3.15 N= 60 σ= 1.28	$\bar{x}$= 3.42 N= 66 σ= 1.68	$\bar{x}$= 2.41 N= 61 σ= 1.10	$\bar{x}$= 2.73 N=105 σ= 1.11

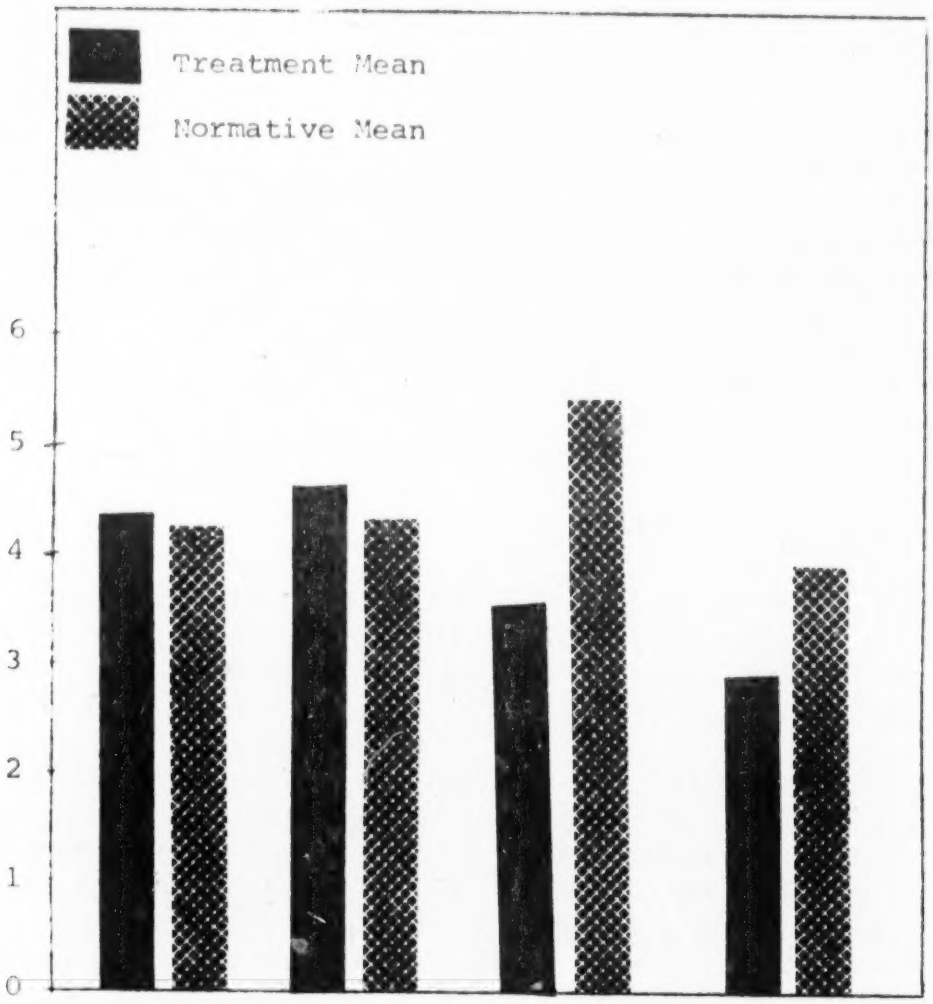

Figure 16.4

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups-- Frostig Subtest 4

Table 16.10

Analysis of Covariance Table for Frostig Subtest 4

Source	η^2	d.f.	Mean Square	F	p
Trt.	.03	3	45.42	3.93	$p < .05$
Sex	.00	1	0.07	0.01	--
Trt. by Sex	.004	3	7.09	0.61	--
Covs.		2	2773.76	240.00	--
Cov. 1		1	8.66	0.75	--
Cov. 2		1	143.64	12.43	--
Error	.97	392	11.56		

(15)

A Dunnett's post-hoc analysis indicates that the two groups visited by a paraprofessional scored significantly better than those which did not receive visits from a paraprofessional. Since no effects were evidenced for the television program, it is likely that the home visitor was responsible for the learning which took place in this area of perceptual development. It is also of interest to note that the two groups visited by the paraprofessional scored at or near the national norms, while the other two groups scored below the norms. A similar pattern also appeared in the second year's data.

Frostig Subtest 5 (Spatial Relationships)

This section of the Frostig is said to measure the ability to make "... the analysis of simple forms and patterns. These consist of lines of various lengths and angles which the child is required to copy, using dots as guide points." (Frostig, 1966, p. 6.)

Essentially, this task involves transposing a specific configuration of lines onto a set of dots, a task which involves both motor coordination and short-term memory for visual designs. Scores for each age-by-sex cell within the four treatments are reflected in the data presented in Table 16.11. Figure 16.5 presents a graphic comparison of the adjusted overall group mean scores on Subtest 5 with normative means for children of similar ages.

Table 16.12 summarizes the results of the analysis of covariance on post-test raw scores for Subtest 5. A Dunnett's post-hoc comparison of the four means showed that the two groups receiving visits from the paraprofessional (TV-HV and TV-HV-MC) outscored their counterparts in two other groups who did not receive these visits. The logical conclusion is that the paraprofessional effectively teaches objectives measured by Subtest 5, which deal with rotation in space and discrimination of "same" and "different" figures. Neither the television program nor the mobile classroom alone had a measurable effect on the area of visual-motor development.

Table 16.11

Frostig Subtest 5 (Spatial Relationships) Pre and Post-test Mean Raw Scores, Standard Deviations, and Numbers of Subjects by Age and Sex Within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 0.30 N= 10 σ= 0.46	$\bar{x}$= 0.67 N= 12 σ= 0.85	$\bar{x}$= 0.18 N= 11 σ= 0.39	$\bar{x}$= 1.19 N= 16 σ= 1.33	$\bar{x}$= 0.36 N= 11 σ= 0.48	$\bar{x}$= 0.25 N= 8 σ= 0.43	$\bar{x}$= 0.00 N= 8 σ= 0.00	$\bar{x}$= 0.47 N= 17 σ= 0.70
	F	$\bar{x}$= 0.41 N= 11 σ= 0.50	$\bar{x}$= 1.31 N= 13 σ= 1.26	$\bar{x}$= 0.14 N= 10 σ= 0.35	$\bar{x}$= 0.61 N= 18 σ= 0.91	$\bar{x}$= 0.20 N= 5 σ= 0.40	$\bar{x}$= 0.20 N= 5 σ= 0.40	$\bar{x}$= 0.13 N= 8 σ= 0.33	$\bar{x}$= 0.68 N= 19 σ= 0.73
4	M	$\bar{x}$= 0.89 N= 9 σ= 0.93	$\bar{x}$= 2.65 N= 20 σ= 1.71	$\bar{x}$= 0.78 N= 9 σ= 0.97	$\bar{x}$= 1.96 N= 25 σ= 1.71	$\bar{x}$= 0.92 N= 13 σ= 0.86	$\bar{x}$= 1.93 N= 14 σ= 1.39	$\bar{x}$= 0.62 N= 13 σ= 0.96	$\bar{x}$= 0.58 N= 17 σ= 1.08
	F	$\bar{x}$= 0.75 N= 9 σ= 1.03	$\bar{x}$= 2.79 N= 19 σ= 1.96	$\bar{x}$= 1.00 N= 10 σ= 1.41	$\bar{x}$= 2.57 N= 22 σ= 1.85	$\bar{x}$= 0.50 N= 10 σ= 0.70	$\bar{x}$= 1.50 N= 8 σ= 1.12	$\bar{x}$= 1.08 N= 13 σ= 1.60	$\bar{x}$= 1.00 N= 17 σ= 1.15
5	M	$\bar{x}$= 2.00 N= 13 σ= 1.73	$\bar{x}$= 4.25 N= 16 σ= 1.56	$\bar{x}$= 2.00 N= 8 σ= 1.85	$\bar{x}$= 3.74 N= 27 σ= 1.88	$\bar{x}$= 0.63 N= 8 σ= 0.74	$\bar{x}$= 2.67 N= 12 σ= 1.80	$\bar{x}$= 1.67 N= 9 σ= 1.87	$\bar{x}$= 2.78 N= 18 σ= 2.30
	F	$\bar{x}$= 2.09 N= 11 σ= 1.51	$\bar{x}$= 3.80 N= 15 σ= 1.94	$\bar{x}$= 2.00 N= 10 σ= 1.70	$\bar{x}$= 3.50 N= 22 σ= 2.15	$\bar{x}$= 1.62 N= 13 σ= 1.61	$\bar{x}$= 2.26 N= 19 σ= 1.65	$\bar{x}$= 1.10 N= 10 σ= 1.45	$\bar{x}$= 2.81 N= 15 σ= 1.93
TOTAL		$\bar{x}$= 1.13 N= 63 σ= 1.16	$\bar{x}$= 2.69 N= 95 σ= 1.64	$\bar{x}$= 0.97 N= 58 σ= 1.23	$\bar{x}$= 2.39 N= 130 σ= 1.73	$\bar{x}$= 0.80 N= 60 σ= 0.97	$\bar{x}$= 1.77 N= 66 σ= 1.40	$\bar{x}$= 0.81 N= 61 σ= 1.27	$\bar{x}$= 1.38 N= 105 σ= 1.43

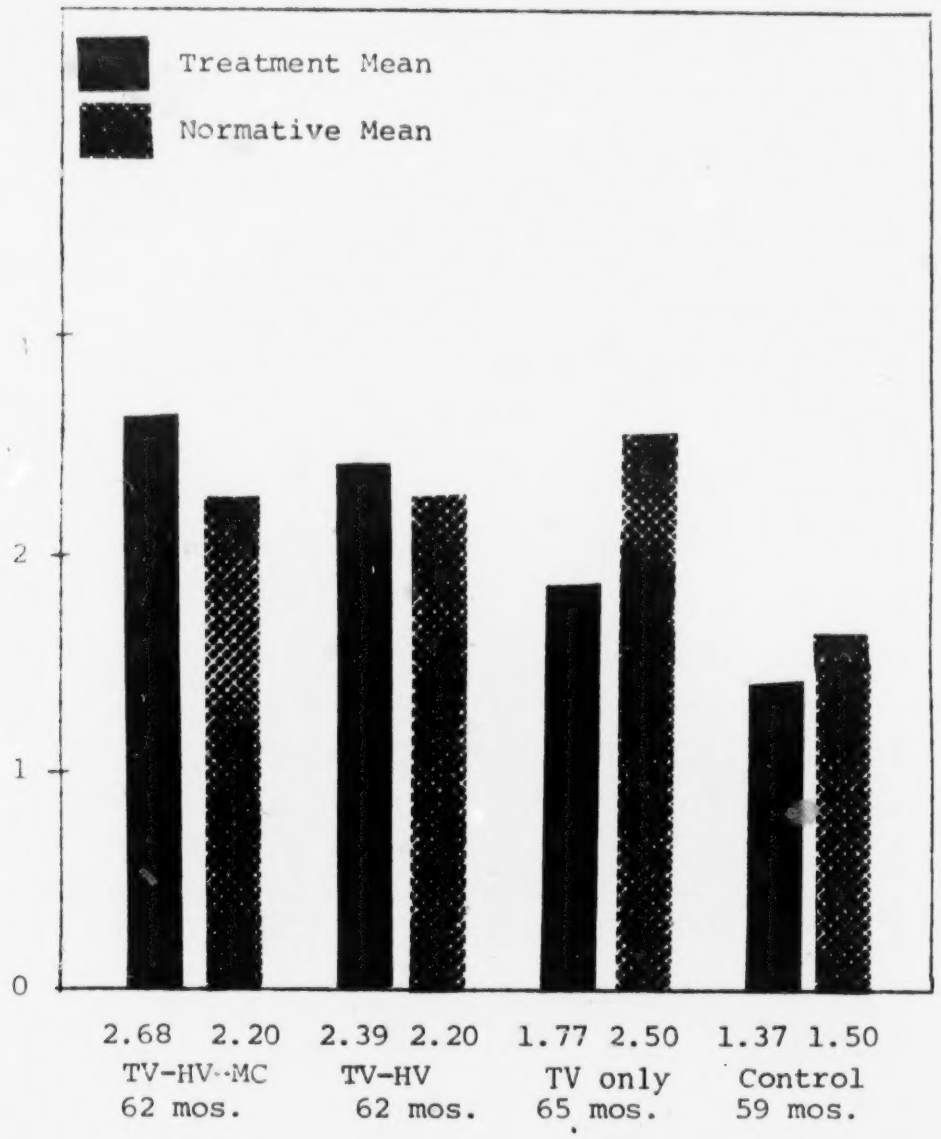

Figure 16.5

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups--
Frostig Subtest 5

Table 16.12

Analysis of Covariance Table for Frostig Subtest 5

Source	η^2	d.f.	Mean Square	F	p
Trt.	.05	3	22.08	7.38	$p < .005$
Sex	.00	1	1.29	0.43	--
Trt. by Sex	.00	3	0.66	0.22	--
Covs.		2	933.81	312.26	--
Cov. 1		1	0.70	0.24	--
Cov. 2		1	89.39	29.89	--
Error	.94	392	2.99		

(18)

Frostig Total Raw Score

As a total instrument, the Frostig measures overall perceptual level as well as the ability to recall and transform visual configurations. It also gives an indication of the child's motor development as reflected by his hand-eye coordination.

Total Frostig raw scores are presented in Table 16.13 for each age-by-sex-cell within the four treatments. Overall raw scores also are presented, collapsing the individual cells for age and sex groups.

Figure 16.6 illustrates adjusted mean totals by group for all five subtests along with a normative total mean score derived by summing the normative means for all subtests.

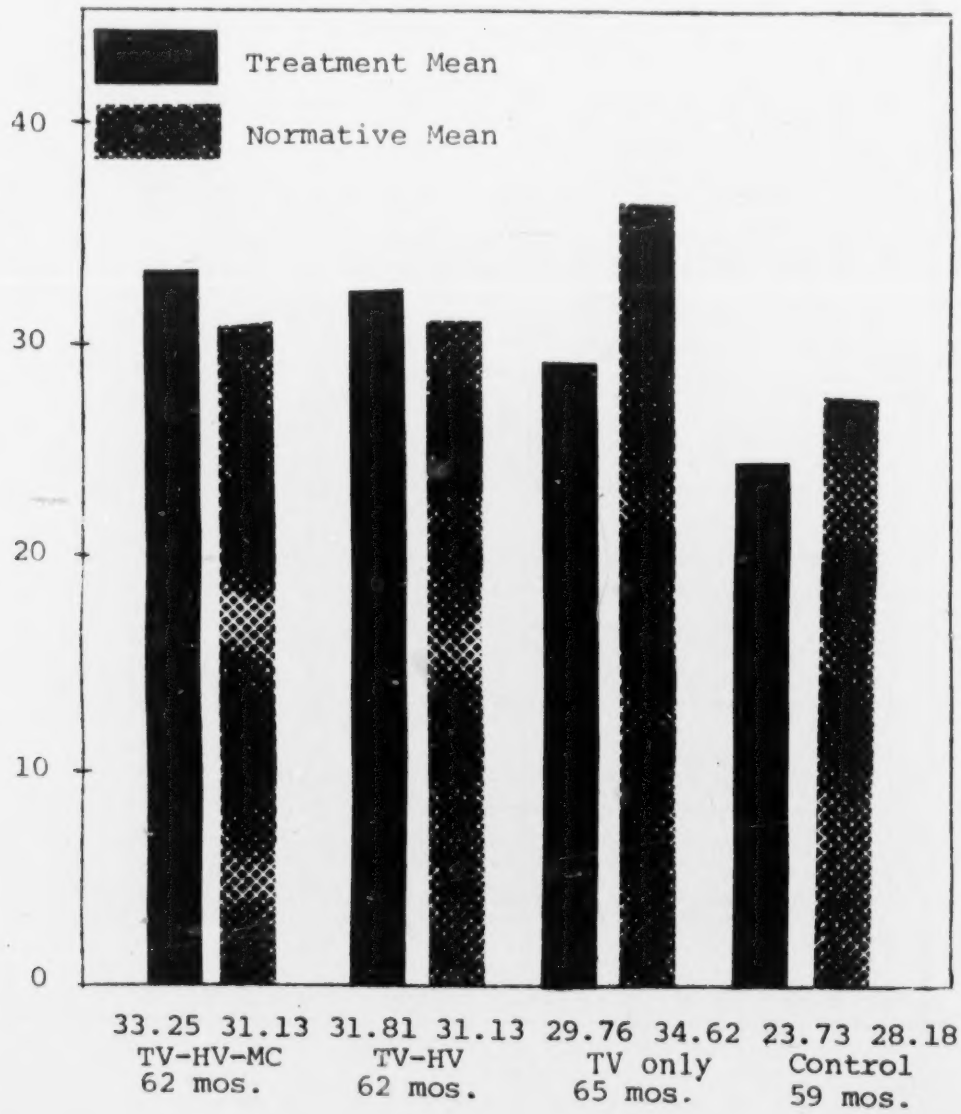

Figure 16.6

Adjusted Post-test Group Scores and Normative Means for Comparable Age Groups--
Frostig Total

(19)

Table 16.13

Frostig Total Pre and Post-test Mean Raw Scores,
Standard Deviations, and Numbers of Subjects
by Age and Sex Within Treatment Groups

Age	Sex	TV-HV-MC		TV-HV		TV only		Control	
		Pretest	Post-test	Pretest	Post-test	Pretest	Post-test	Pretest	Post-test
3	M	$\bar{x}$= 5.91 N= 10 σ= 5.04	$\bar{x}$= 14.92 N= 12 σ= 6.16	$\bar{x}$= 12.33 N= 11 σ= 7.96	$\bar{x}$= 19.31 N= 16 σ= 8.15	$\bar{x}$= 8.27 N= 11 σ= 7.82	$\bar{x}$= 9.88 N= 8 σ= 5.25	$\bar{x}$= 7.88 N= 8 σ= 4.46	$\bar{x}$= 14.24 N= 17 σ= 5.67
	F	$\bar{x}$= 12.18 N= 11 σ= 5.73	$\bar{x}$= 23.38 N= 13 σ= 9.83	$\bar{x}$= 7.70 N= 10 σ= 6.87	$\bar{x}$= 15.44 N= 18 σ= 8.64	$\bar{x}$= 9.60 N= 5 σ= 5.95	$\bar{x}$= 11.40 N= 5 σ= 9.22	$\bar{x}$= 8.00 N= 8 σ= 4.36	$\bar{x}$= 14.53 N= 19 σ= 9.22
4	M	$\bar{x}$= 20.88 N= 9 σ= 9.25	$\bar{x}$= 31.85 N= 20 σ= 10.46	$\bar{x}$= 19.78 N= 9 σ= 11.66	$\bar{x}$= 27.80 N= 25 σ= 11.82	$\bar{x}$= 21.00 N= 13 σ= 14.14	$\bar{x}$= 34.93 N= 14 σ= 11.65	$\bar{x}$= 14.85 N= 13 σ= 9.14	$\bar{x}$= 20.05 N= 17 σ= 1.06
	F	$\bar{x}$= 18.25 N= 9 σ= 13.60	$\bar{x}$= 34.68 N= 19 σ= 13.12	$\bar{x}$= 28.30 N= 10 σ= 9.94	$\bar{x}$= 35.04 N= 22 σ= 11.71	$\bar{x}$= 16.10 N= 10 σ= 8.94	$\bar{x}$= 25.88 N= 8 σ= 16.37	$\bar{x}$= 15.38 N= 13 σ= 9.60	$\bar{x}$= 23.80 N= 17 σ= 10.09
5	M	$\bar{x}$= 32.31 N= 13 σ= 11.18	$\bar{x}$= 47.38 N= 16 σ= 11.36	$\bar{x}$= 44.63 N= 8 σ= 11.75	$\bar{x}$= 42.15 N= 27 σ= 8.11	$\bar{x}$= 25.38 N= 8 σ= 14.14	$\bar{x}$= 34.67 N= 12 σ= 13.43	$\bar{x}$= 23.44 N= 9 σ= 12.87	$\bar{x}$= 33.17 N= 18 σ= 10.82
	F	$\bar{x}$= 31.18 N= 11 σ= 12.89	$\bar{x}$= 41.47 N= 15 σ= 8.85	$\bar{x}$= 32.10 N= 10 σ= 14.30	$\bar{x}$= 43.41 N= 22 σ= 10.91	$\bar{x}$= 29.92 N= 13 σ= 14.25	$\bar{x}$= 37.74 N= 19 σ= 11.22	$\bar{x}$= 29.60 N= 10 σ= 11.86	$\bar{x}$= 36.00 N= 15 σ= 11.84
TOTAL		$\bar{x}$= 20.77 N= 63 σ= 10.16	$\bar{x}$= 33.25 N= 95 σ= 10.47	$\bar{x}$= 23.31 N= 58 σ= 10.61	$\bar{x}$= 31.82 N= 130 σ= 9.78	$\bar{x}$= 19.42 N= 60 σ= 11.89	$\bar{x}$= 29.77 N= 66 σ= 11.84	$\bar{x}$= 16.84 N= 61 σ= 9.49	$\bar{x}$= 23.76 N= 105 σ= 8.88

The differences between treatment and sex means are significant at the .01 level as shown in the ANCOVA summary in Table 16.14. Differences between pairs of means which contributed to the overall treatment effect were subjected to a Dunnett's post-hoc analysis. All three treatment groups were significantly higher than the control group, while no meaningful differences were found between any of the treatment groups, a pattern which was evident in the previous year's data. This finding points to the overall effectiveness of the television program in promoting visual-motor development.

Table 16.14

Analysis of Covariance Table for Frostig Total Score

Source	η^2	d.f.	Mean Square	F	p
Trt.	.05	3	874.73	7.06	p < .01
Sex	.01	1	655.89	5.29	p < .01
Trt. by Sex	.00	3	3.43	0.03	--
Covs.		2	181452.77	1463.73	--
Cov. 1		1	587.72	4.74	--
Cov. 2		1	9313.36	75.13	--
Error	.94	392	123.97		

The significant sex effect for the Frostig total score favored the females. Table 16.15 shows scores for both sexes derived from the ANCOVA adjusted means.

Table 16.15

Adjusted Post-test Total Frostig Mean Scores for Males and Females

	TV-HV-MC	TV-HV	TV	C
M	32.74	31.50	28.94	23.40
F	33.72	32.16	30.65	24.11

Although the differences are small, girls consistently outscore their male counterparts in terms of overall perceptual-motor development. This pattern is not modified by the program treatment effects.

Summary and Implications

The following tabulation lists the probable effects of various program components on the areas measured by the Frostig:

- Mobile facility - no effects.
- Paraprofessional - significant contribution in the area of same-different discrimination in terms of spatial rotation.
- Television program - major effect on eye-motor coordination, shape constancy, and the ability to conserve patterns after spatial rotation. Additionally, the television program apparently caused a significant contribution to the total raw score.

Where sex differences existed, they constantly favored females over males, even when treatment effects also were present. This pattern indicates an overall developmental difference between males and females in terms of perceptual-motor development as measured by this test.

In summary, the television program seemed to have a broad effect on children's perceptual motor development, and this effect probably involved perceptual learning from viewing the program and motor learning from active involvement in the drawing, cutting and other manual tasks taught on Around the Bend.

Home visitors evidently made a significant contribution in the area of discrimination of spatial rotation, which may well have been related to their emphasis on same-different relations.

Ranking the treatment means across subtests results in the following table:

	TV-HV-MC	TV-HV	TV only	Control
Frostig 1	2	3	1	4
Frostig 2	2	1	3	4
Frostig 3	1	2	3	4
Frostig 4	2	1	3	4
Frostig 5	1	2	3	4
Frostig Total	1	2	3	4

This illustrates the dichotomy between the scores of the children who were visited by the paraprofessional and those who were not. It clearly shows the impact of the home visitor on the development of child's visual-motor skills.

(22)

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Hooper, Frank H. and William H. Marshall. The Initial Phase of a Preschool Curriculum Development Project - Final Report (Charleston, W.Va.: Appalachia Educational Laboratory, Inc., 1968).